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# Telecommunication Networks: Challenges and Changes

Ali Amiri
*Oklahoma State University*, amiri@okstate.edu

Mark Weiser
*Oklahoma State University*, weiser@okstate.edu

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Ali Amiri, Department of Management, Oklahoma State University, amiri@okstate.edu
Mark Weiser, Department of Management, Oklahoma State University, weiser@okstate.edu

Perhaps the most profound impact on business and personal productivity, since the introduction of the personal computer, has been the increasing voice, video, and data connectivity. This interaction may bring about a fundamental change in the way we live in the 21st century. In addition to technological improvements that support communication of a variety of media, a great convergence of technologies like televisions, telephones, computers, and networks continues. Although the growth of telecommunications over the past decade has been phenomenal, we expect that the explosion of telecommunications applications is still to come. Although there are continuous advancements in telecommunications the target infrastructure for many of these advanced applications is the Internet -- a system based on a 1981 IETF specification -- very much an anomaly in the rapidly changing technology world (Amiri and Pirkul, 1996).

Telecommunication networks play a crucial role in modern societies. An ever-increasing number of users are completely relying on them in their activities today. Technological advances have led to the introduction of new services based on telecommunication networks such as teleconferencing, electronic commerce, video on demand, etc. Telecommunication systems involve multi-billion dollar investments and yearly expenses of billions of dollars. It is easy to see that telecommunications has changed and will continue to change almost every aspect of our personal and professional lives. Telecommunications plays and will continue to play major roles in the success of regions and entire nations with respect to most sectors of the economy.

The area of telecommunication networks has received a lot of attention from practitioners and researchers alike. Many companies have established internal research centers to help plan and manage their networks. The number of publications that concentrate exclusively or partially on the area of telecommunications has increased dramatically in the past few years. This area gets the attention of researchers and investigators associated with several fields such as electrical engineering, computer science, operations research, organization behavior and marketing. In fact, new degree programs devoted solely to telecommunications have been created in several universities to deal with the extreme shortages of telecommunication professionals within the telecommunication industries (Sharda, 1998).

Gavish (1995) has identified several major issues facing telecommunications industries and their customers that represent both challenges and research opportunities for both practitioners and researchers. The first set of issues is related to changes in the wire-based telecommunication systems. The wire-based systems have started to rely more heavily on fiber cables that are more reliable and offer higher bandwidth than copper cables. Coaxial cables that were mainly used for television reception are now being used to provide additional services such as telephone and internet access. Some of the transition and expansion issues related to this are studied to some extent in (Balakrishnan 1991 & 1995; Chang, 1993 & 1995 Dutta 1992 & 1996), but a lot more has to be done to address the integration and expansion problems of existing and future networks.

The success of a telecommunication network depends heavily on the assignment of capacities to the links and switches and on the strategy of routing traffic from sources to destinations. Indeed, the response time to users of a telecommunication network is considerably affected by the capacities available on the links over time and by the way the increasing user traffic requirements are routed on these links. In addition, the cost of the link installation and maintenance constitutes an important portion of the total investment of the design of a telecommunication network. As such, the planning of network design and capacity allocation and routing is of vital importance in many organizations within the private and public sectors. A lot of research has been done in this area (Amiri, 1997; Amiri, 1999; Gavish, 1990; LeBlanc, 1989; Ng, 1987).

The use of high bandwidth transmission media such as fiber optics makes millions of users vulnerable in case of link/node failure. Few research studies have addressed the reliability issue of designing “traditional” networks with relatively low bandwidth (Amiri, 1996; Gavish, 1992; Monma, 1989; Pirkul, 1994). However, new methodologies are needed for the reliable design of high bandwidth, low failure rate systems.

The development of new technologies (e.g., ATM) that allow different types of traffic such as data, voice and video to be transmitted over the same network has created new challenges and research opportunities related to queueing models of the new switches, dynamic reconfiguration of the networks, the handling of highly bursty traffic sources, etc.

The growth of wireless and mobile communications has also created research opportunities regarding making proper decisions related to several issues including the number of base stations and their locations, the types and capacities of transmission equipment placed on the base stations. More studies are needed to deal with the impact of new technologies such as personal communication systems, micro and picocells. From a marketing point of view, studies are needed to help decision makers select the types of services to offer and their prices.

Another area in telecommunications that needs more attention is research on satellite-based communication systems, especially low and medium earth orbit satellite (LEOS/MEOS). Issues related to this area include constellation and satellite configuration, channel allocation, power management, and satellite launching and replacement (Gavish, 1992).

The emphasis on the Internet for commerce and communications has directed large amounts of resources to research and development in that area. Certain features of Internet Protocol version 4 (IPv4) are inadequate to best support many current and future applications on that network, however, there is strong resistance to a transition to IPv6. These issues are detailed by Weiser (2000).

Telecommunications, including the carriage of voice, video, and data is one of the most critical and rapidly changing areas in Information Technology. Research in this area must continue to look forward to leverage the possibilities of today's networks and shape the future of communication for the next generation of applications.

## References


Amiri, A. and H. Pirkul. "Primary and Secondary Route Selection in Backbone Communication Networks," *European Journal of Operational Research* 93 (1996) 98-109.

Amiri, A. and H. Pirkul. "Routing and Capacity Assignment in Backbone Communication Networks," *Computers & Operations Research* 24 (1997) 275-287.

Amiri, A. and H. Pirkul. "Routing and Capacity Assignment in Backbone Communication Networks Under Time Varying Traffic Conditions," *European Journal of Operational Research* 117 (1999) 15-29.

Balakrishnan, A., T. L. Magnanti, A. Shulman and R. T. Wong. "Models for Planning Capacity Expansion in Local Access Telecommunication Networks," *Annals of Operations Research* 33 (1991) 239-284.

Balakrishnan, A., T. Magnanti and R. Wong. "A Decomposition Algorithm for Local Access Telecommunication Network Expansion Planning," *Operations Research* 43(1995) 58-76.

Chang, S. and B. Gavish. "Telecommunications Network Topological Design and Capacity Expansion: Formulations and Algorithms," *Telecommunication Systems* 1 (1993) 99-131.

Chang, S. and B. Gavish. "Lower Bounding Procedures for Multiperiod Telecommunications Network Expansion Problems," *Operations Research* 43 (1995) 43-57.

Dutta, A. and Y. K. Kim. "A Multiperiod Capacity Planning Model for Backbone Computer Communication Networks," *Operations Research* 40 1(992) 689-705.

Dutta, A. and Y. K. Kim. "A heuristic Approach for Capacity Expansion of Packet Networks," *European Journal of Operational Research* 91 (1996) 395-410.

Gavish, B. and K. Altinkemer. "Backbone network design tools with economic tradeoffs," *ORSA J. on Computing* 2, 226-252 (1990).

Gavish, B. and I. Newman. "Routing in a network with unreliable components," *IEEE Transactions on Communications* 40 (1992) 1249-1257.

Gavish, B. "Telecommunications: A Revolution in Progress," *Operations Research*, 43 (1) (1995) 29-32.

Gavish, B. "Low Earth Orbit Satellite Based Communication Systems - Research Opportunities," *European Journal of Operational Research*, 99 (1997) 166-179.

LeBlanc, L. and R. V. Simmons. "Continuous models for capacity design of large packet-switched telecommunication networks," *ORSA Journal on Computing* 1 (1989) 271-286.

Monma, C. and D. Schallcross. "Methods for Designing Communication Networks With Certain Two-Connected Survivability Constraints", *Operations Research* 37, (1989) 531-541.

Ng, T. and D. Hoang. "Joint Optimization of Capacity and Flow Assignment in a Packet- Switched Communications Network," *IEEE Transactions on Communications* 35 (1987) 202-209.

Pirkul, H. and S. Narasimhan. "Primary and Secondary Route Selection in Backbone Data Communication Networks," *ORSA Journal on Computing* 6 (1994) 50-60.

Weiser, M.. "What Happened to the Next Generation Internet," *Communications of the ACM*, forthcoming, 2000.